



10/01/99

\*\*\*\*\*

|   |  |                         |
|---|--|-------------------------|
| <b>UTILITY<br/>PATENT APPLICATION<br/>TRANSMITTAL</b><br><small>(Only for new nonprovisional applications under 37 CFR 1.53(b))</small> | Attorney Docket No.                      | 0557-4784-2             |
|   | First Inventor or Application Identifier | Wataru NARA             |
|   | Title                                    | IMAGE READING APPARATUS |

 JCS68 U.S. PTO  
 09 41629  
 10/01/99

|   |  |
|---|--|
| <b>APPLICATION ELEMENTS</b><br><small>See MPEP chapter 600 concerning utility patent application contents</small>   | <b>ADDRESS TO:</b> Assistant Commissioner for Patents<br>Box Patent Application<br>Washington, DC 20231  |
| 1. <input checked="" type="checkbox"/> Fee Transmittal Form (e.g. PTO/SB/17)<br><small>(Submit an original and a duplicate for fee processing)</small><br><br>2. <input checked="" type="checkbox"/> Specification <span style="float: right;">Total Pages <b>43</b></span><br><br>3. <input checked="" type="checkbox"/> Drawing(s) (35 U.S.C. 113) <span style="float: right;">Total Sheets <b>6</b></span><br><br>4. <input type="checkbox"/> Oath or Declaration <span style="float: right;">Total Pages <span style="border: 1px solid black; padding: 0 10px;">  </span></span><br>a. <input type="checkbox"/> Newly executed (original or copy)<br>b. <input type="checkbox"/> Copy from a prior application (37 C.F.R. §1.63(d))<br><i>(for continuation/divisional with box 16 completed)</i><br>i. <input type="checkbox"/> <b>DELETION OF INVENTOR(S)</b><br>Signed statement attached deleting inventor(s) named<br>in the prior application, see 37 C.F.R. §1.63(d)(2) and<br>1.33(b).<br><br>5. <input type="checkbox"/> Incorporation By Reference <i>(usable if box 4B is checked)</i><br>The entire disclosure of the prior application, from which a copy of the<br>oath or declaration is supplied under Box 4B, is considered to be part<br>of the disclosure of the accompanying application and is hereby<br>incorporated by reference therein. | <b>ACCOMPANYING APPLICATION PARTS</b><br><br>6. <input type="checkbox"/> Assignment Papers (cover sheet & document(s))<br>7. <input type="checkbox"/> 37 C.F.R. §3.73(b) Statement <input type="checkbox"/> Power of Attorney<br><i>(when there is an assignee)</i><br>8. <input type="checkbox"/> English Translation Document <i>(if applicable)</i><br>9. <input checked="" type="checkbox"/> Information Disclosure Statement (IDS)/PTO-1449 <input checked="" type="checkbox"/> Copies of IDS<br>Citations (3)<br>10. <input type="checkbox"/> Preliminary Amendment<br>11. <input checked="" type="checkbox"/> White Advance Serial No. Postcard<br><br>12. <input type="checkbox"/> Small Entity Statement(s) <input type="checkbox"/> Statement filed in prior<br>application. Status still proper<br>and desired.<br>13. <input checked="" type="checkbox"/> Certified Copy of Priority Document(s) (1)<br><i>(if foreign priority is claimed)</i><br>14. <input checked="" type="checkbox"/> Other: Notice of Priority, List of Inventor's<br>Name and Address |
| 15. If a CONTINUING APPLICATION, check appropriate box, and supply the requisite information below.<br><input type="checkbox"/> Continuation <input type="checkbox"/> Divisional <input type="checkbox"/> Continuation-in-part (CIP) of prior application no.:<br>Prior application information: Examiner: Group Art Unit:  |  |
| 16. Amend the specification by inserting before the first line the sentence:<br><input type="checkbox"/> This application is a <input type="checkbox"/> Continuation <input type="checkbox"/> Division <input type="checkbox"/> Continuation-in-part (CIP)<br>of application Serial No. Filed on<br><br><input type="checkbox"/> This application claims priority of provisional application Serial No. Filed   |  |
| <b>17. CORRESPONDENCE ADDRESS</b><br><br>OBLON, SPIVAK, MCCLELLAND, MAIER & NEUSTADT, P.C.<br>FOURTH FLOOR<br>1755 JEFFERSON PARK HIGHWAY<br>ARLINGTON, VIRGINIA 22202<br>(703) 413-3000<br>FACSIMILE: (703) 413-2220   |  |

|            |                            |                   |         |
|------------|----------------------------|-------------------|---------|
| Name:      | Marvin J. Spivak           | Registration No.: | 24,913  |
| Signature: |                            | Date:             | 10/1/99 |
| Name:      | Registration Number 21,124 | Registration No.: |         |

SPECIFICATION

TO ALL WHOM IT MAY CONCERN:

BE IT KNOWN THAT I, WATARU NARA, a  
citizen of Japan residing at Kanagawa, Japan have  
invented certain new and useful improvements in

IMAGE READING APPARATUS

of which the following is a specification:-

1     BACKGROUND OF THE INVENTION

1.   Field of the Invention

          The present invention relates to an image  
reading apparatus which uses a photoelectric device  
such as a charge-coupled device (CCD) or the like, and  
5     generates an image signal from an original image, and,  
in particular, to an image reading apparatus which  
performs correction, using data of a black reference  
level, on image data obtained from the original image  
10    through the photoelectric device.

2.   Description of the Related Art

          An image reading apparatus in the related  
art, which apparatus uses a photoelectric device such  
15    as a charge-coupled device (CCD) or the like, and  
generates an electric image signal from an original  
image, performs a correction, using data of a black  
reference level, on image data obtained from the  
original image through the photoelectric device. The  
20    method thereof will now be described.

          Generally speaking, an image signal  
outputted from a CCD includes a signal component due  
to a dark current which does not change due to change  
in an amount of light received by the CCD, and a  
25    signal component which changes in accordance with the

1 change in the amount of light received by the CCD. A  
signal component which is effective for image  
processing is only the signal component which changes  
in accordance with the change in the amount of light  
5 received by the CCD. Accordingly, in order to obtain  
the signal component which is to be outputted to a  
following image processing circuit, it is necessary to  
perform the correction (black shading correction) to  
subtract the data of the signal component due to the  
10 dark current from the data of the image signal  
outputted from the CCD.

The signal component due to the dark current  
can be obtained as a result of outputs of an optical  
black (OPB) portion provided as part of a line of  
15 photoelectric sensors of the CCD (scan beginning part  
in a main scan direction, as shown in FIG. 1) being  
averaged, before the CCD reads the original image, for  
each line, for example. The OPB portion provided as  
the part of the line of the photoelectric sensors of  
20 the CCD is obtained as follows: Aluminum deposition  
is performed on several (for example, eight, sixteen,  
or the like) photoelectric sensors of the line of the  
(for example, thousands of) photoelectric sensors of  
the CCD, each photoelectric sensor corresponding to a  
25 pixel, which several photoelectric sensors are

1 arranged at the end at which scanning in the main scan  
direction begins. Thereby, these several  
photoelectric sensors of the CCD are covered by the  
aluminum film, and, as a result, are shielded from  
5 light, and, thus, no light is received by these  
several photoelectric sensors of the CCD. Thereby,  
the data of the black reference level can be obtained  
using the data obtained from the several photoelectric  
sensors of the OPB portion of the CCD.

10 FIG. 2 is a block diagram showing essential  
portions of one example of an image reading apparatus  
including a black shading correction portion for  
performing the above-mentioned correction (black  
shading correction) in the related art.

15 The image reading apparatus shown in FIG. 2  
includes a CCD portion 1 which comprises a CCD  
including a line of photoelectric sensors extending in  
the main scan direction, and generates an image signal  
from an original image as a result of reading the  
20 original image. The reading of the original image is  
performed as follows: The CCD portion 1 scans a first  
line of the original image in the main scan direction  
along the line of the photoelectric sensors of the CCD  
(whereby image data of the first line is obtained) and  
25 scans the original image in the sub-scan direction

1 (perpendicular to the main scan direction) by  
sequentially scanning subsequent lines of the original  
image (whereby image data of respective lines, i.e., a  
second line, a third line, ..., an n-th line, is  
5 obtained in sequence). The CCD of the CCD portion 1  
is the same as the above-described CCD having the OPB  
portion. The image reading apparatus further includes  
a signal processing portion 2 which performs  
processing of an analog image signal outputted from  
10 the CCD portion 1, an A-D converting portion 3 which  
is an A-D converter converting the analog image signal  
into a digital image signal, a peak hold (P/H) portion  
4 for detecting a background level of the original  
image, a black shading correction portion 5 which  
15 performs the correction, using the data of the black  
reference level, on the image signal, and a white  
shading correction portion 6 which performs white  
shading correction on the image signal. Further, the  
black shading correction portion 5 includes an  
20 average-value calculating circuit 7 which calculates  
the average of the outputs of the CCD portion 1 during  
the period during which the CCD portion 1 obtains data  
(to be used for obtaining the black reference level)  
through the photoelectric sensors of the above-  
25 mentioned OPB portion of the CCD, and a subtractor 8

1     which subtracts the average calculated by the average-  
value calculating circuit from the data of the image  
signal obtained from the original image.

5     In FIG. 2, the image analog signal outputted  
by the CCD portion 1 undergoes signal processing  
through the signal processing portion 2, and, then, is  
converted into the digital image signal by the A-D  
converting portion 3. The digital image signal  
outputted from the A-D converting portion 3 is  
10    inputted to the black shading correction portion 5,  
undergoes the black shading correction therethrough,  
and, then, is outputted. The image signal outputted  
from the black shading correction portion 5 is  
inputted to the white shading correction portion 6.  
15    The white shading correction portion 6 performs the  
white shading correction on the data of the thus-  
inputted image signal using white reference data which  
was obtained using a white reference plate or the  
like. Then, the image signal is inputted to an image  
20    processing block (not shown in the figure).

25    In the black shading correction portion 5,  
the average calculating circuit 7 calculates the  
average of the outputs from the OPB portion in the CCD  
portion 1 as the data of the reference black level at  
the beginning of reading of an original image for each

1 line, and outputs the thus-calculated average Dopb  
(the average of the pixel values (of the OPB portion)  
in the main scan direction). The subtracter 8, which  
has received the average Dopb, subtracts the average  
5 Dopb from the data D0 of the image signal (outputted  
from the A-D converting portion 3 when the original  
image is read), and outputs the thus-obtained data to  
the white shading correction portion 6. Thus, the  
black shading correction portion 5 averages the data  
10 outputted from the OPB portion of the CCD portion 1  
for each line, and, thereby, obtains the data of the  
black reference level to be used for the black shading  
correction to eliminate the black offset from the  
image signal. The calculation of the average  
15 performed by the average calculating circuit 7 is  
performed only during the period during which the  
average calculating circuit receives an OPBGATE  
signal, which is provided to the average calculating  
circuit 7 only during the period during which data  
20 obtained from the OPB portion in the CCD portion 1 is  
outputted from the CCD portion 1.

As shown in FIG. 2, the peak hold (P/H)  
portion 4 is connected between the signal processing  
portion 2 and the A-D converting portion 3. The peak  
25 hold portion 4 holds the peak value of the output from



1 the signal processing portion 2, and provides the peak  
value to the A-D converting portion 3 as the reference  
voltage of the A-D converting portion 3. Thus, the  
peak hold portion 4 detects the color level of the  
5 background of the original image, and provides the  
thus-detected level to the A-D converting portion 3 as  
the reference voltage. Thereby, the influence of the  
color of the background of the original image on the  
image signal outputted from the A-D converting portion  
10 3 is eliminated.

The peak value of the image signal varies  
due to variation in the color of the background of the  
original image. In many cases, the original image  
read by the image reading apparatus is an image  
15 printed on a paper sheet. In such a case, the above-  
mentioned color of the background of the original  
image is the color of this paper sheet. The color of  
the paper sheet on which the original image was  
printed is ordinarily white. However, there is a case  
20 where the color of the paper sheet on which the  
original image was printed is not white, but is red,  
for example. Therefore, the peak value of the image  
signal varies as the color of the paper sheet on which  
the original image was printed varies. As a result,  
25 the output of the peak hold portion 4 varies, and,

1 accordingly, the reference voltage of the A-D  
converting portion 3 varies. Thereby, the output from  
the A-D converting portion 3 varies. As a result, the  
level of the black offset which should be eliminated  
5 from the image signal through the black shading  
correction performed by the black shading correction  
portion 5 varies. Therefore, the black shading  
correction to eliminate the black offset from the  
image signal performed by the black shading portion 5  
10 should be performed at the same time (in real time)  
the image signal obtained when the background of the  
original image is read is processed.

However, the number of the photoelectric  
sensors of the CCD which can be used as the OPB  
15 portion is limited, because almost all of the  
photoelectric sensors are used for reading the  
original image and the photoelectric sensors used as  
the OPB portion cannot be used for reading the  
original image. Therefore, when the signal-to-noise  
20 ratio (S/N ratio) of the image reading apparatus is  
bad, variation in the average of the outputs of the  
photoelectric sensors of the OPB portion occurs due to  
the noise. Thereby, the black reference level used  
for the black shading correction may vary for each  
25 line due to the noise. When the black reference level

1 varies for each line due to the noise, the following  
situation occurs: Although the black offset level of  
the original image does not vary or varies smoothly in  
the sub-scan direction, a pattern of lateral stripes  
5 develops in the image represented by the image signal,  
because the black reference level used for the black  
shading correction varies for each line due to the  
noise, and, thereby, the level of the image signal  
obtained through the black shading correction varies  
10 for each line.

#### SUMMARY OF THE INVENTION

The present invention has been devised in  
order to solve the above-described problem, and an  
15 object of the present invention is to provide an image  
reading apparatus by which the black shading  
correction to eliminate the black offset can be  
performed at the same time (in real time) the image  
signal obtained when the background level of the  
20 original image is read is processed, and, also,  
variation in the average of outputs of the OPB portion  
for each line can be controlled.

An image reading apparatus, according to the  
present invention, comprises:  
25 photoelectrically converting means for

1     photoelectrically converting image information  
obtained from optically reading an original image,  
line by line, and outputting an image signal, the  
photoelectrically converting means having optically  
5     shielding means provided at a portion thereof; and  
black shading correction means for  
correcting the image signal using a black reference  
level, the black reference level being obtained from  
the portion of the photoelectrically converting means  
10    for each line during an operation of the reading of  
the original image,

wherein the black reference level used by  
the black shading correction means for each line is  
obtained using black reference values, each of the  
15    black reference values being data of the portion of  
the photoelectrically converting means for a  
respective one of a plurality of lines.

In this arrangement, the black reference  
level used by said black shading correction means for  
20    each line is obtained using black reference values,  
each of the black reference values being data of the  
portion of the photoelectrically converting means for  
a respective one of a plurality of lines. Thereby, it  
is possible to control the variation in the level of  
25    the image signal for each line due to the variation in

1     the black reference level used by the black shading  
correction means for each line due to noise.

      The black reference level may be a weighted  
average of the black reference values.

5     Thereby, it is possible to control the  
variation in the level of the image signal for each  
line due to the variation in the black reference level  
used by the black shading correction means for each  
line due to noise, and, also, it is possible to enable  
10    the correction performed by the black shading  
correction means to well follow the variation in the  
black offset level of the image signal due to  
variation in the level of the image signal, for each  
line, by appropriately selecting the above-mentioned  
15    plurality of lines and appropriately determining the  
coefficient of the weighted-averaging.

      The black reference value for a respective  
line may be an average of pixel values in a main scan  
direction, and the weighted average of the black  
20    reference values is obtained from weighted-averaging,  
in a sub-scan direction, the black reference values.

      The black reference level for each line may  
be obtained from weighted-averaging the black  
reference value for the current line and the black  
25    reference level for the preceding line.

1           In this arrangement, it is possible to  
enable the correction performed by the black shading  
correction means to well follow the variation in the  
black offset level of the image signal due to  
5   variation in the level of the image signal, for each  
line, and, also, it is possible to reduce the size of  
the arrangement of the black shading correction means.

The black reference level may be a moving  
average of the black reference values.

10           In this arrangement, it is possible to  
simplify the arrangement of the black shading  
correction means.

The black reference value for a respective  
line may be an average of pixel values in a main scan  
15   direction, the moving average being obtained from  
moving-averaging, in a sub-scan direction, the black  
reference values.

The black reference level for each line may  
be obtained from moving-averaging the black reference  
20   values for the plurality of lines.

The plurality of lines may comprise the  
current line and preceding lines.

In this arrangement, it is possible to  
enable the correction performed by the black shading  
25   correction means to well follow the variation in the

1     black offset level of the image signal due to  
variation in the level of the image signal, for each  
line.

Other objects and further features of the  
5     present invention will become more apparent from the  
following detailed description when read in  
conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

10     FIG. 1 shows an arrangement of photoelectric  
sensors of a CCD used for reading an original image in  
an image reading apparatus in each of the related art,  
and first and second embodiments of the present  
invention;

15     FIG. 2 is a block diagram showing essential  
portions of an image reading apparatus in the related  
art;

FIG. 3 is a block diagram showing essential  
portions of an image reading apparatus in the first  
20     embodiment of the present invention;

FIG. 4 is a block diagram showing an  
internal arrangement of a black shading correction  
portion shown in FIG. 3;

25     FIG. 5 is a block diagram showing essential  
portions of an image reading apparatus in the second

1      embodiment of the present invention; and

FIG. 6 is a block diagram showing an internal arrangement of a black shading correction portion shown in FIG. 5.

5

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Embodiments of the present invention will now be described.

FIG. 3 is a block diagram showing essential portions of an image reading apparatus, in a first embodiment of the present invention, including a black shading correction portion, which performs the black shading correction.

As shown in FIG. 3, the image reading apparatus in the first embodiment includes a CCD portion 1 which comprises a CCD including a line of photoelectric sensors extending in the main scan direction, and generates an image signal as a result of reading an original image. The reading of the original image is performed as follows: The CCD portion 1 scans a first line of the original image in the main scan direction along the line of the photoelectric sensors of the CCD (whereby image data of a first line is obtained) and scans the original image in the sub-scan direction (perpendicular to the



1 main scan direction) by sequentially scanning  
subsequent lines of the original image (whereby image  
data of respective lines, i.e., a second line, a third  
line, ..., an n-th line, is obtained in sequence).

5 The CCD of the CCD portion 1 is the same as the above-  
described CCD having the OPB portion. The image  
reading apparatus further includes a signal processing  
portion 2 which performs processing of an analog image  
signal outputted from the CCD portion 1, an A-D

10 converting portion 3 which is an A-D converter  
converting the analog image signal into a digital  
image signal, a peak hold (P/H) portion 4 for  
detecting a background level of the original image, a  
black shading correction portion 15 which performs a

15 black shading correction, using the data of the black  
reference level, on the image signal, and a white  
shading correction portion 6 which performs a white  
shading correction on the image signal.

The arrangement of the image reading

20 apparatus in the first embodiment is the same as the  
image reading apparatus in the related art shown in  
FIG. 2, except for the black shading correction  
portion 15. That is, each of the portions 1, 2, 3, 4  
and 6 of the image reading apparatus in the first

25 embodiment is the same as a respective one of the

1 portions 1, 2, 3, 4 and 6 in the related art shown in  
FIG. 2.

The black shading correction portion 15  
includes an average calculating circuit 17 which  
5 calculates the average of outputs of the CCD portion 1  
during the period during which the CCD portion 1  
outputs data obtained through the photoelectric  
sensors of the above-mentioned OPB portion of the CCD,  
a weighted-average circuit 19 which performs weighted-  
10 averaging using values outputted from the average  
calculating circuit 17, and a subtracter 18 which  
subtracts the value calculated by the weighted-average  
circuit 19 from the data of the image signal outputted  
from the A-D converting circuit 3.

15 In FIG. 3, the analog image signal outputted  
by the CCD portion 1 undergoes signal processing  
through the signal processing portion 2, and, then, is  
converted into the digital image signal by the A-D  
converting portion 3. The digital image signal  
20 outputted from the A-D converting portion 3 is  
inputted to the black shading correction portion 15,  
undergoes the black shading correction therethrough,  
and, then, is outputted. The image signal outputted  
from the black shading correction portion 15 is  
25 inputted to the white shading correction portion 6.

1 The white shading correction portion 6 performs the  
white shading correction of the data of the thus-  
inputted image signal using white reference data which  
was obtained using a white reference plate or the  
5 like. Then, the image signal is inputted to an image  
processing block (not shown in the figure).

The average calculating circuit 17 of the  
black shading correction portion 15 obtains outputs of  
the OPB portion of the CCD portion 1 (from the CCD  
10 portion 1 via the signal processing portion 2 and A-D  
converting portion 3) before the CCD portion 1 reads  
the original image, for each line. Then, the average  
calculating circuit 17 calculates the average of these  
outputs, and outputs the average as  $D_{opb}$ . The  
15 weighted-average circuit 19, which receives the  
average  $D_{opb}$ , calculates a weighted average  $D_{b,n}$  (data  
of a black reference level) using the average  $D_{opb}$ ,  
and outputs the calculated weighted average  $D_{b,n}$  to  
the subtracter 18. The weighted average  $D_{b,n}$  results  
20 from a weighted-average calculation being repeated for  
each line from the second line to the current line,  
the weighted-average calculation using the average  
 $D_{opb,1}$  for the first line through the average  $D_{opb,n}$   
for the current line. The subtracter 18, which has  
25 received the weighted average  $D_{b,n}$ , subtracts the

1 weighted average  $Db,n$  from the data  $D0$  of the image  
signal (outputted from the A-D converting portion 3  
when the original image is read), and outputs the  
thus-obtained data to the white shading correction  
5 portion 6. The calculation of the average performed  
by the average calculating circuit 17 is performed  
only during the period during which the average  
calculating circuit 17 receives the OPBGATE signal,  
which is provided to the average calculating circuit  
10 17 only during the period during which the data  
obtained from the OPB portion of the CCD portion 1 is  
outputted from the CCD portion 1.

Further, in the arrangement of the first  
embodiment shown in FIG. 3, as in the related art  
15 shown in FIG. 2, the peak hold (P/H) portion 4 is  
connected between the signal processing portion 2 and  
the A-D converting portion 3. The peak hold portion 4  
holds the peak value of the output from the signal  
processing portion 2, and provides the peak value to  
20 the A-D converting portion 3 as the reference voltage  
of the A-D converting portion 3. Because the  
operation of the peak hold circuit 4 in the first  
embodiment is the same as the operation of the peak  
hold circuit 4 in the related art shown in FIG. 2,  
25 further description is omitted.

1           As described above, in the black shading  
correction portion 15 in the first embodiment, the  
data of the black reference level for eliminating the  
black offset from the image signal is obtained as a  
5       result of performing weighted-averaging using the  
average of the data obtained from the data outputted  
from the OPB portion of the CCD of the CCD portion 1  
for the first line through the average of the data  
obtained from the data outputted from the OPB portion  
10      of the CCD of the CCD portion for the current line in  
sequence. In this case, the weighted average  $Db,n$  is  
obtained from the following equation (1), for example:

$$15 \quad Db,n = Dopb,n / A + Db,n-1 \times (A-1) / A \quad \dots (1)$$

where:

' $Db,n$ ' represents the data of the black  
reference level (which is subtracted from the data D0  
of the image signal through the subtracter 18) for the  
20    n-th line;

' $Db,n-1$ ' represents the data of the black  
reference level (which is subtracted from the data D0  
of the image signal through the subtracter 18) for the  
(n-1)-th line;

25       ' $Dopb,n$ ' represents the average or a

1 weighted average of the data obtained from the data  
outputted from the OPB portion for the n-th line (that  
is, the average or a weighted average of the data of  
the image signal outputted from the A-D converting  
5 portion 3 during the period during which the data  
obtained from the OPB portion of the CCD portion 1 is  
outputted from the CCD portion 1 before the original  
image is read for the n-th line); and

'A' represents a constant (weighted-average  
10 coefficient).

However, when the image data for the first  
line is processed, that is, when  $n = 1$ ,

$$D_{b,1} = D_{opb,1}$$

15

Assuming that the S/N ratio of the image  
reading apparatus is bad, and, thereby, the average  
 $D_{opb,n}$  of the data obtained from the data outputted  
from the OPB portion for each line varies, the average  
20  $D_{opb,n}$  is expressed as follows:

$$D_{opb,n} = D_{b,n-1} + \alpha \quad \dots (2)$$

where  $\alpha$  represents the variation due to the  
25 noise.

1           As a result of substitution of the equation  
(2) in the equation (1), the following equation (3) is  
obtained:

5            $Db,n = Db,n-1 + \alpha / A \quad \dots (3)$

From the equation (3), it can be seen that,  
by performing the weighted-averaging as in the first  
embodiment of the present invention, the variation  $\alpha$   
10 due to the noise is reduced by a factor of A.

FIG. 4 is a block diagram showing the  
internal arrangement of the weighted-average circuit  
19.

The weighted-average circuit 19 includes a  
15 multiplier 21 which multiplies the weighted average  
 $Db,n-1$  for the preceding line, outputted from the  
weighted-average circuit 19, by  $(A - 1)$ , an adder 20  
which adds the value outputted from the multiplier 21  
to the average  $Dopb,n$ , provided by the average  
20 calculating circuit 17, and a divider 22 which divides  
the value outputted from the adder 20 by A so as to  
output the weighted average  $Db,n$  (the data of the  
black reference level which is subtracted from the  
data D0 of the image signal through the subtracter  
25 18). However, when the image data for the first line

1 is processed, that is, when  $n = 1$ , the weighted-  
average circuit 19 outputs the inputted average  
Dopb,1, as it is, as the data Db,1 of the black  
reference level (which is subtracted from the data D0  
5 of the image signal through the subtracter 18) for the  
first line.

In the arrangement shown by the block  
diagrams of FIGS. 3 and 4, the value obtained as a  
result of weighted-averaging shown in the above-  
10 mentioned equation (1) being performed is outputted to  
the subtracter 18. Accordingly, as shown in the  
above-mentioned equation (3), it is possible to reduce  
the variation due to the noise by the factor of A.

Thus, by using the weighted-average circuit  
15 19, it is possible to take measures to deal with the  
situation that the S/N ratio of the image reading  
apparatus is bad, using the very simple arrangement at  
a low cost.

Further, as a feature of the weighted-  
20 average circuit, as shown in the above-mentioned  
equation (1), the data Db,n of the black reference  
level for the current line is affected by the average  
Dopb,n for the current line most greatly. Thereby, by  
using the weighted-average circuit, it is possible  
25 that the black shading correction well follows the



1     variation in the black offset level.

          In a case where the above-described  
weighted-average circuit 19 is formed by hardware, the  
calculation can be performed only by shifting of the  
5     register values when the constant A used in the above-  
mentioned equation (1) is determined to be a power of  
two (for example, 2, 4, 8 or the like). Thereby, it  
is possible to simplify the arrangement of the  
hardware.

10           Instead of performing the weighted-average  
calculation as in the first embodiment, it is also  
possible to perform a moving-average calculation using  
the average  $Dopb, n-m$  for the  $(n - m)$ -th line ( $m$ -th  
previous line) through the average  $Dopb, n$  for the  $n$ -th  
15     line (current line). Also in this case, it is  
possible to reduce the influence due to a bad S/N  
ratio of the image reading apparatus on the black  
reference level used for the black shading correction.

          FIG. 5 is a block diagram showing essential  
20     portions of an image reading apparatus, in a second  
embodiment of the present invention, including a black  
shading correction portion, which performs the black  
shading correction using the data of the black  
reference level obtained as a result of performing the  
25     above-mentioned moving-average calculation.

1           As shown in FIG. 5, the image reading  
apparatus in the second embodiment includes a CCD  
portion 1 which comprises a CCD including a line of  
photoelectric sensors extending in the main scan  
5       direction, and generates an image signal as a result  
of reading an original image. The reading of the  
original image is performed as follows: The CCD  
portion 1 scans a first line of the original image in  
the main scan direction along the line of the  
10      photoelectric sensors of the CCD (whereby image data  
of the first line is obtained) and scans the original  
image in the sub-scan direction (perpendicular to the  
main scan direction) by sequentially scanning  
subsequent lines of the original image (whereby image  
15      data of respective lines, i.e., a second line, a third  
line, ..., an n-th line, is obtained in sequence).  
The CCD of the CCD portion 1 is the same as the above-  
described CCD having the OPB portion. The image  
reading apparatus further includes a signal processing  
20      portion 2 which performs processing of an analog image  
signal outputted from the CCD portion 1, an A-D  
converting portion 3 which is an A-D converter  
converting the analog image signal into a digital  
image signal, a peak hold (P/H) portion 4 for  
25      detecting the background level of the original image,

1 a black shading correction portion 25 which performs a  
black shading correction, using the data of the black  
reference level, on the image signal, and a white  
shading correction portion 6 which performs a white  
5 shading correction on the image signal.

The arrangement of the image reading  
apparatus in the second embodiment is the same as the  
image reading apparatus in the first embodiment shown  
in FIG. 3, except for the black shading correction  
10 portion 25. That is, each of the portions 1, 2, 3, 4  
and 6 of the image reading apparatus in the second  
embodiment is the same as a respective one of the  
portions 1, 2, 3, 4 and 6 in the first embodiment  
shown in FIG. 3.

15 The black shading correction portion 25  
includes an average calculating circuit 17 which  
calculates the average Dopb of the outputs of the CCD  
portion 1 (obtained via the signal processing portion  
2 and A-D converting portion 3) during the period  
20 during which the CCD portion 1 obtains data through  
the photoelectric sensors of the above-mentioned OPB  
portion of the CCD, a moving-average circuit 29 which  
performs moving-averaging using values outputted from  
the average calculating circuit 17, and a subtracter  
25 18 which subtracts the moving average Db thus

1     calculated by the moving-average circuit 19 from the  
data D0 of the image signal outputted from the A-D  
converting circuit 3 when the original image is read.

5     In FIG. 5, the analog image signal outputted  
by the CCD portion 1 undergoes signal processing by  
the signal processing portion 2, and, then, is  
converted into the digital image signal by the A-D  
converting portion 3. The digital image signal  
10    outputted from the A-D converting portion 3 is  
inputted to the black shading correction portion 25,  
undergoes the black shading correction therethrough,  
and, then, is outputted. The image signal outputted  
from the black shading correction portion 25 is  
inputted to the white shading correction portion 6.  
15    The white shading correction portion 6 performs the  
white shading correction of the data of the thus-  
inputted image signal using the white reference data  
which was obtained using a white reference plate or  
the like. Then, the image signal is inputted to an  
20    image processing block (not shown in the figure).

      The average calculating circuit 17 of the  
black shading correction portion 25 calculates the  
average of outputs of the OPB portion of the CCD  
portion 1 (obtained from the CCD portion 1 via the  
25    signal processing portion 2 and A-D converting portion

1     3) before the CCD portion 1 reads the original image,  
for each line. Then, the average calculating circuit  
17 outputs the thus-calculated average  $D_{opb}$ . The  
moving-average circuit 29, which receives the average  
5      $D_{opb}$ , calculates a moving average  $D_{b,n}$  (the average,  
in the sub-scan direction, of  $(m + 1)$  averages, each  
of which averages is the average in the main scan  
direction) and outputs the moving average  $D_{b,n}$  to the  
subtractor 18. The moving average  $D_{b,n}$  is obtained as  
10     a result of a moving-average calculation being  
performed using the average  $D_{opb,n-m}$  for the  $(n - m)$ -  
th line ( $m$ -th previous line) through the average  
 $D_{opb,n}$  for the  $n$ -th line (current line). The  
subtractor 18, which has received the moving average  
15      $D_{b,n}$ , subtracts the moving average  $D_{b,n}$  from the data  
 $D_0$  of the image signal outputted from the A-D  
converting portion 3 when the original image is read,  
and outputs the thus-obtained data to the white  
shading correction portion 6. The calculation of the  
20     average performed by the average calculating circuit  
17 is performed only during the period during which  
the average calculating circuit 17 receives the  
OPBGATE signal which is provided to the average  
calculating circuit 17 only during the period during  
25     which the data obtained from the OPB portion of the

1 CCD portion 1 is outputted from the CCD portion 1.

Further, in the arrangement of the second  
embodiment shown in FIG. 5, as in the first embodiment  
shown in FIG. 3, the peak hold (P/H) portion 4 is  
5 connected between the signal processing portion 2 and  
the A-D converting portion 3. The peak hold portion 4  
holds the peak value of the output from the signal  
processing portion 2, and provides the peak value to  
the A-D converting portion 3 as the reference voltage  
10 of the A-D converting portion 3. Because the  
operation of the peak hold circuit 4 in the second  
embodiment is the same as the operation of the peak  
hold circuit 4 in the first embodiment shown in FIG.  
3, further description is omitted.

15 As described above, in the black shading  
correction portion 25 in the second embodiment, the  
data of the black reference level for eliminating the  
black offset from the image signal is obtained as a  
result of performing moving-averaging using the  
20 average of the data obtained from the data outputted  
from the OPB portion of the CCD of the CCD portion 1  
for the  $(n - m)$ -th line ( $m$ -th previous line) through  
the average of the data obtained from the data  
outputted from the OPB portion of the CCD of the CCD  
25 portion 1 for the  $n$ -th line (current line). In this

1 case, the moving average  $Db,n$  is obtained from the  
following equation (4), for example:

$$5 \quad (4) \quad Db,n = \Sigma Dopb,x (n - m, n) / (m + 1) \quad \dots$$

where:

' $Db,n$ ' represents the value of the black  
reference level (which is subtracted from the data D0  
10 of the image signal through the subtracter 18) for the  
 $n$ -th line;

' $\Sigma Dopb,x (n - m, n)$ ' represents the sum of  
the  $Dopb,x$  for  $x = n - m$  through  $n$ , that is, the sum  
of  $Dopb,n-m$  through  $Dopb,n$ ; and

15 ' $Dopb,x$ ' represents the average or a  
weighted average of the data obtained from the data  
outputted from the OPB portion for the  $x$ -th line (that  
is, the average or a weighted average of the data of  
the image signal outputted from the A-D converting  
20 portion 3 during the period during which the data  
obtained from the OPB portion of the CCD portion 1 is  
outputted from the CCD portion 1 before the original  
image is read for the  $x$ -th line).

However, when  $1 < n \leq m$ ,

25

1            $Db, n = \Sigma Dopb, x (1, n) / n$

          where ' $\Sigma Dopb, x (1, n)$ ' represents the sum of  
the  $Dopb, x$  for  $x = 1$  through  $n$ , that is, the sum of  
5    $Dopb, 1$  through  $Dopb, n$ .

          When  $n = 1$ ,

$Db, 1 = Dopb, 1$

10           FIG. 6 is a block diagram showing the  
internal arrangement of the moving-average circuit 29.

          As shown in FIG. 6, the moving-average  
circuit 29 includes a latch circuit 30 which latches  
the average  $Dopb, n-m$  for the  $(n - m)$ -th line through  
15 the average  $Dopb, n-1$  for the  $(n - 1)$ -th line, which  
were already outputted from the average calculating  
circuit 17 in sequence, and outputs the thus-latched  
values in parallel. The moving-average circuit 29  
further includes an average calculating circuit 31  
20 which calculates the sum of the average  $Dopb, n$  for the  
 $n$ -th line (current line), outputted from the average  
calculating circuit 17 and the average  $Dopb, n-m$  for  
the  $(n - m)$ -th line through the average  $Dopb, n-1$  for  
the  $(n - 1)$ -th line, outputted from the latch circuit  
25 30. Then, the average calculating circuit 30 divides



1 the thus-obtained sum by  $(m + 1)$ , that is, by the  
total number of the averages  $Dopb, n-m$  through  $Dopb, n$   
inputted to the average calculating circuit 30.

However, when  $1 < n \leq m$ , the latch circuit  
5 30 latches the average  $Dopb, 1$  for the first line  
through the average  $Dopb, n-1$  for the  $(n - 1)$ -th line,  
already outputted from the average calculating circuit  
17 in sequence, and outputs the thus-latched values in  
parallel. The average calculating circuit 31  
10 calculates the sum of the average  $Dopb, n$  for the  $n$ -th  
line (current line), outputted from the average  
calculating circuit 17 and the average  $Dopb, 1$  for the  
first line through the average  $Dopb, n-1$  for the  $(n -$   
 $1)$ -th line, outputted from the latch circuit 30.  
15 Then, the average calculating circuit 30 divides the  
thus-obtained sum by  $n$ , that is, by the total number  
of the averages  $Dopb, 1$  through  $Dopb, n$  inputted to the  
average calculating circuit 30.

When  $n = 1$ , the moving-average portion 29  
20 outputs the inputted average  $Dopb, 1$ , as it is, as the  
black reference value  $Db, 1$ .

When comparing the first embodiment, shown  
in FIGS. 3 and 4, with the second embodiment, shown in  
FIGS. 5 and 6, the first embodiment is superior for  
25 the following reasons.

1           In the second embodiment, it is necessary to  
increase the number  $(m + 1)$  of the averages  $Dopb, n-m$   
through  $Dopb, n$  (the average  $Db, n$  of which averages is  
used as the data of the black reference level to be  
5 subtracted from the data  $D0$  of the image signal in the  
black shading correction), in order to increase the  
accuracy of the data of the black reference level used  
for the black shading correction, that is, in order to  
increase the accuracy of the value  $Db, n$  to be  
10 subtracted from the data  $D0$  of the image signal so as  
to eliminate the black offset from the image signal.  
For this purpose, a large number of registers are  
needed, and, as a result, the size of the entire  
circuit increases. Further, in this case, because the  
15 number  $(m + 1)$  of the averages  $Dopb, n-m$  through  $Dopb, n$   
(the average  $Db, n$  of which averages is used as the  
data of the black reference level) increases, it is  
not possible that the black shading correction well  
follows the variation in the black offset level.

20           In order to enable the black shading  
correction to well follow the variation in the black  
offset level, it is necessary to reduce the number  $(m$   
 $+ 1)$  of the averages  $Dopb, n-m$  through  $Dopb, n$  (the  
average  $Db, n$  of which averages is used as the data of  
25 the black reference level). However, in this case,

1 the accuracy of the data of the black reference level  
decreases. Thereby, it is not possible to  
sufficiently reduce the influence due to a bad S/N  
ratio of the image reading apparatus on the data of  
5 the black reference level used for the black shading  
correction. For example, it is merely possible to  
reduce the variation due to the noise by a factor of 2  
or 3, although it is possible to reduce the variation  
due to the noise by the factor of A in the first  
10 embodiment as shown in the above-mentioned equation  
(3), where the constant A can be adjusted  
appropriately.

Thus, although the arrangement, such as that  
in the second embodiment, in which the data of the  
15 black reference level is obtained through the moving-  
averaging in the sub-scan direction of the averages,  
each being the average of the pixel values of the OPB  
portion in the main scan direction, is possible, the  
arrangement, such as that in the first embodiment, in  
20 which the black reference level is obtained through  
the weighted-averaging in the sub-scan direction of  
the averages, each being the average of the pixel  
values of the OPB portion in the main scan direction,  
is superior.

25 Thus, as a result of the weighted-average or

1 the moving-average of values, each of the values being  
data of the shielded portion (OPB portion) of the  
photoelectric device for a respective line, being used  
as the data of the black reference level used for the  
5 black shading correction, it is possible to control  
the variation in the level of the image signal for  
each line due to the variation in the black reference  
level used for the black shading correction for each  
line due to noise, and, also, it is possible to enable  
10 the black shading correction to well follow the  
variation in the black offset level of the image  
signal due to variation in the level of the image  
signal, for each line.

The present invention is not limited to the  
15 above-described embodiments, and variations and  
modifications may be made without departing from the  
scope of the present invention.

The present invention is based on Japanese  
priority application No. 10-296061 filed on October 2,  
20 1998, the entire contents of which are hereby  
incorporated by reference.

1    WHAT IS CLAIMED IS

5

1. An image reading apparatus, comprising:
- photoelectrically converting means for  
photoelectrically converting image information  
obtained from optically reading an original image,  
10 line by line, and outputting an image signal, said  
photoelectrically converting means having optically  
shielding means provided at a portion thereof; and
- black shading correcting means for  
correcting the image signal using a black reference  
15 level, said black reference level being obtained from  
said portion of said photoelectrically converting  
means for each line during an operation of the reading  
of the original image,
- wherein the black reference level used by  
20 said black shading correcting means for each line is  
obtained using black reference values, each of the  
black reference values being data of said portion of  
said photoelectrically converting means for a  
respective one of a plurality of lines.

25

1           2. The image reading apparatus, as claimed  
in claim 1, wherein the black reference level is a  
weighted average of the black reference values.

5

3. The image reading apparatus, as claimed  
in claim 2, wherein the black reference value for a  
10    respective line is an average of pixel values in a  
main scan direction, and the weighted average of the  
black reference value is obtained from weighted-  
averaging, in a sub-scan direction, the black  
reference values.

15

4. The image reading apparatus, as claimed  
20    in claim 1, wherein the black reference level for each  
line is obtained from weighted-averaging the black  
reference value for the current line and the black  
reference level for the preceding line.

25

1           5. The image reading apparatus, as claimed  
in claim 1, wherein the black reference level is a  
moving average of the black reference values.

5

6. The image reading apparatus, as claimed  
in claim 5, wherein the black reference level for a  
10    respective line is an average of pixel values in a  
main scan direction, the moving average being obtained  
from moving-averaging, in a sub-scan direction, the  
black reference values.

15

7. The image reading apparatus, as claimed  
in claim 1, wherein the black reference level for each  
20    line is obtained from moving-averaging the black  
reference values for the plurality of lines.

25

1           8. The image reading apparatus, as claimed  
in claim 7, wherein the plurality of lines comprise  
the current line and preceding lines.

5

          9. An image reading apparatus, comprising:  
          a photoelectric unit which photoelectrically  
10       converts image information obtained from optically  
reading an original image, line by line, and outputs  
an image signal, said photoelectric unit having an  
optically shielding member provided at a portion  
thereof; and  
15       a black shading correcting unit which  
corrects the image signal using a black reference  
level, said black reference level being obtained from  
said portion of said photoelectric unit for each line  
during an operation of the reading of the original  
20       image,  
          wherein the black reference level is  
obtained using black reference values, each of the  
black reference values being data of said portion of  
said photoelectrically converting means for a  
25       respective one of the plurality of lines.



1           10. The image reading apparatus, as claimed  
in claim 9, wherein the black reference level is a  
weighted average of the black reference values.

5

10           11. The image reading apparatus, as claimed  
in claim 10, wherein the black reference value for a  
respective line is an average of pixel values in a  
main scan direction, and the weighted average of the  
black reference values is obtained from weighted-  
averaging, in a sub-scan direction, the black  
reference values.

15

12. The image reading apparatus, as claimed  
20 in claim 9, wherein the black reference level for each  
line is obtained from weighted-averaging the black  
reference value for the current line and the black  
reference level for the preceding line.

25

1           13. The image reading apparatus, as claimed  
in claim 9, wherein the black reference level is a  
moving average of the black reference values.

5

10           14. The image reading apparatus, as claimed  
in claim 13, wherein the black reference value for a  
respective line is an average of pixel values in a  
main scan direction, the moving average being obtained  
from moving-averaging, in a sub-scan direction, the  
black reference values.

15

20           15. The image reading apparatus, as claimed  
in claim 9, wherein the black reference level for each  
line is obtained from moving-averaging the black  
reference values for the plurality of lines.

25

1           16. The image reading apparatus, as claimed  
in claim 15, wherein the plurality of lines comprise  
the current line and preceding lines.

5

10

15

20

25

1     ABSTRACT OF THE DISCLOSURE

          A CCD photoelectrically converts image  
information obtained from optically reading an  
original image, line by line, and outputs an image  
5     signal. Several of the photoelectric sensors of a CCD  
of the CCD portion form an optical black portion. A  
black shading correcting portion corrects the image  
signal using a black reference level. The black  
reference level is obtained from the optical black  
10    portion of the CCD for each line during an operation  
of the reading of the original image. The black  
reference level used by said black shading correcting  
portion for each line is obtained using black  
reference values, each of the black reference values  
15    being data of the optical black portion for a  
respective one of a plurality of lines.

20

25

FIG. 1

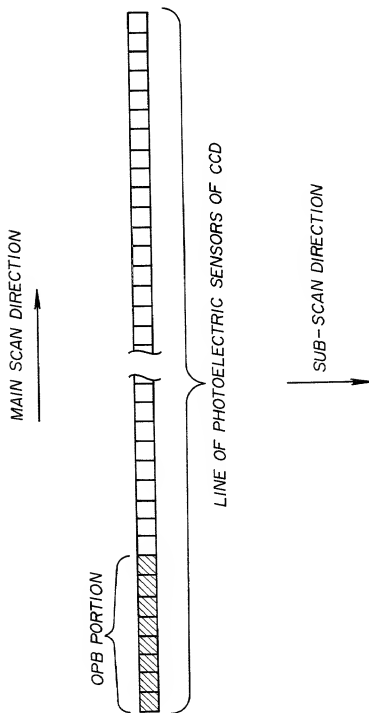


FIG. 2

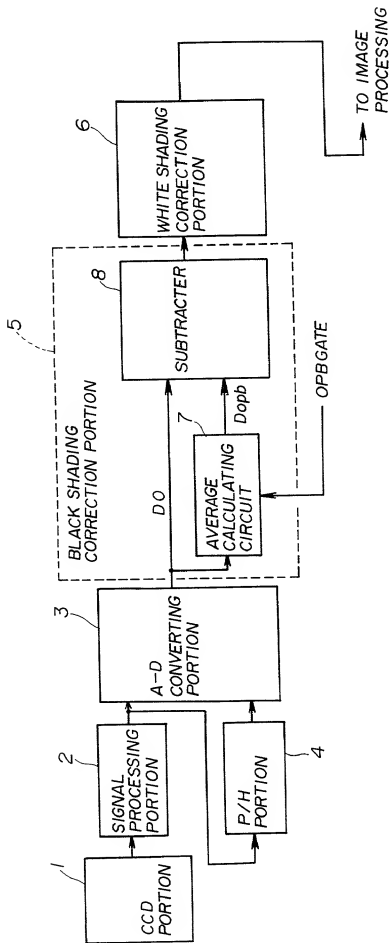


FIG. 3

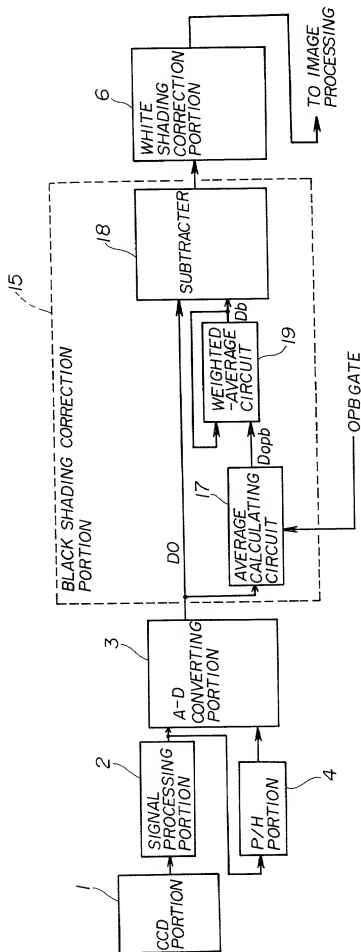


FIG. 4

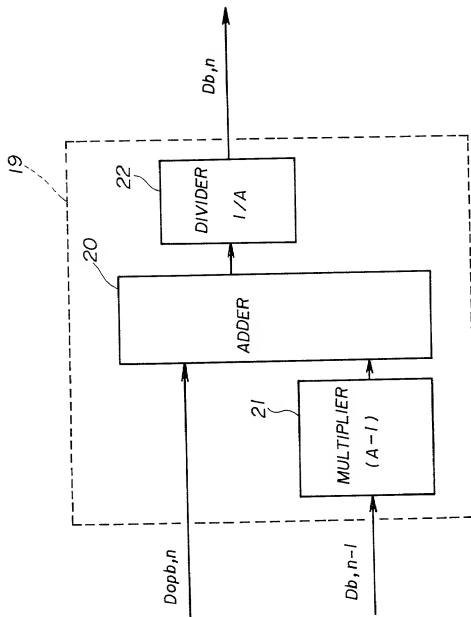




FIG. 5

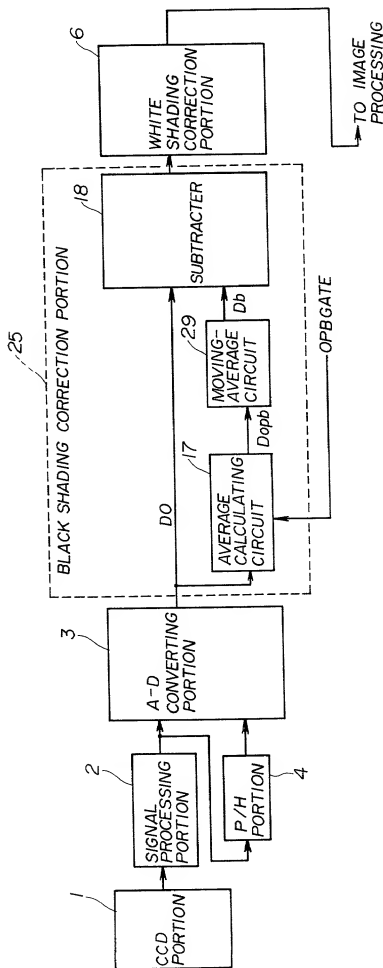


FIG. 6

